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Analyzing Change of Direction and the Laterally Resisted Split Squat: Incorporating a Lateral Vector into the Single Leg Squat

Derek Maddy
Boise State University

Chance Cooley
Boise State University

Tyler Brown
Boise State University

Shawn Simonson
Boise State University

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INTRODUCTION

Agility – The ability to change directions in response to a stimulus[1]

- Cognitive – How quickly the brain processes information in response to a stimulus (motor learning)
- Physical – How the body applies the information to change directions (change of direction: COD)

Frequently tested in athletes to predict success[2-4]

COD Characteristics[2]

- Unilateral
- Horizontal and Lateral Force Production
- Hamstring & Gluteal Muscle Activation

IMPROVING COD MOVEMENT

Dos'Santos et al analyzed mechanical determinants for faster COD in athletes[5]

- Participants with faster ground contact time and higher horizontal propulsive forces have quicker COD[5]
- Slower participants have greater vertical impact forces and smaller horizontal propulsive forces during COD[5]

Mixed Results for Improving COD via Strength Training

- Spiteri et al correlation of strength to COD[6]
  - Jullien et al – No improvement via concentric squat training[7]
  - McBride et al – Improvement via eccentric training & motor learning effect[8]
  - Castillo-Rodriguez et al – Improvement unilateral CMJ but injuries occurred[9]
  - Speirs et al - Modified Single Leg Squat (MSLS) and Bilateral Squat (BS) resulted in similar improvement in COD[10]

FORCE VECTOR THEORY

Specificity of Strength Training – Training that targets the muscles used during athletic skills is best for direct transferability[11]

- Training adaptations may be direction-specific and exercises should exhibit concentric and eccentric loads in the same anatomical plane as in the athletic movement[12-14]
- For COD, a transverse plane force is required for improved performance

  There currently is no resistance training movement that does this.
  - MSLS targets muscles used during COD and is performed in unilateral fashion; however, the MSLS is performed in an upright position and resisting a vertical downward force
  - COD is not performed in an upright vertical position. This may reduce the transferability from the MSLS to COD

The Laterally Resisted Split Squat (LRSS) is a modification of the MSLS that incorporates a lateral force vector

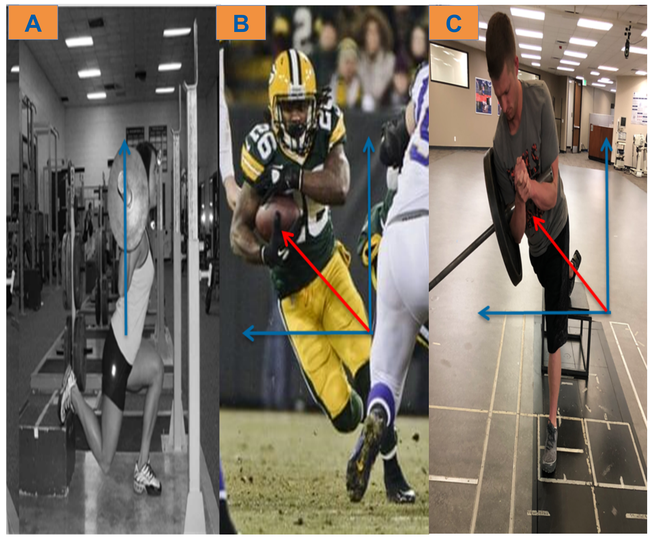

Figure 1: An American football player performing a change in direction (B), comparing force production of the MSLS (A) and LRSS (C).[15]

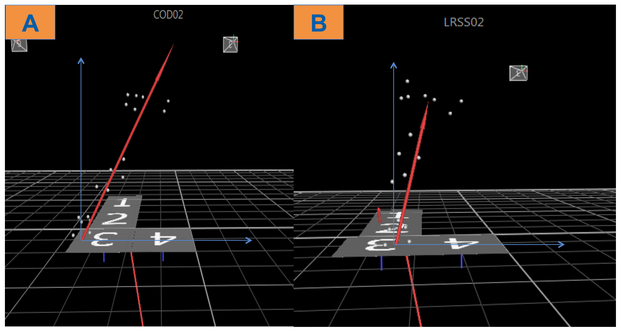

Figure 2: Pilot data comparing the GRF vector between a 90° COD at the start of the propulsive phase (A) and the LRSS during the concentric phase of the lift (B).

PURPOSE AND HYPOTHESIS

The purpose of this study is to compare COD with the LRSS, MSLS and the BS via kinetic measurements and muscle activation.

Hypothesis I: It is hypothesized that horizontal ground reaction force (HGRF) of the LRSS will be no different than COD, but will be significantly different than the BS.

a) It is hypothesized that horizontal GRF of the LRSS will be significantly different than the MSLS.

Hypothesis II: It is hypothesized that the LRSS will require greater muscle activation in the bicep femoris, semimembranosus, gluteus maximus, and gluteus medius than the BS.

a) It is hypothesized that the LRSS will require greater muscle activation in the bicep femoris, semimembranosus, gluteus maximus, and gluteus medius than the MSLS.

METHODS

Participants

12 recreational college athletes participating in COD sports

- No previous lower limb injury over last 6 months
- No previous lower limb surgical procedures
- Provide written consent & health history form

Measurements

- LRSS, MSLS, BS - Indirect 1RM[16]
- Peak HGRF (HGRF= $((ML^2 + A - P^2)/BM))^{½}$; AMTI FP)[11]
- Peak Muscle Activation (MVC; Delsys Trigno)[17]

Protocol

1) COD mechanic screening
2) Familiarization of LRSS
3) Indirect 1RM – LRSS, MSLS, BS
4) COD on Dominant Leg (GRF)
5) MVC
6) 3 Movements 70% 1RM

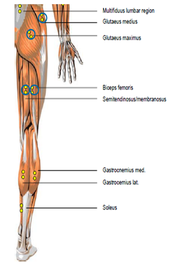

Figure 3: EMG placements of surface electrodes.[17]

Data Analysis

SPSS 25 (α=0.05)

- RM-ANOVA
  - HGRF of LRSS, MSLS, BS
  - EMG Peak Activation of LRSS, MSLS, BS

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